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IS 12389 (1988): Seamless and Welded Titanium and Titanium Alloy Fittings [MTD 7: Light Metals and their Alloys]

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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartṛhari—Nītiśatakam

“Knowledge is such a treasure which cannot be stolen”



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Indian Standard

SPECIFICATION FOR SEAMLESS AND WELDED TITANIUM AND TITANIUM ALLOY FITTINGS

1. Scope — The term 'fittings' has been applied to cover seamless and welded parts of construction, such as caps, tees, reducers, lap joint stab ends, flanges, etc, and the term 'welded fittings' applies to fusion welding parts only. Changes in the corrosion and strength properties of the titanium fittings that may occur by virtue of their galvanic contacts with other materials in corrosive liquids are not covered in this specification.

2. Material Grades — Material shall be graded on the basis of chemical composition and mechanical properties according to requirements stipulated in Table 1. In case of welded and seamless products, the permissible variation in chemical composition shall conform to the tolerance limits given in Table 2.

3. Chemical Requirements — Chemical composition of the material shall conform to that prescribed in Table 1.

3.1 Unless otherwise agreed to the detailed report, chemical composition shall be provided by the manufacturer.

3.2 Chemical analysis may be carried out by using any established standard chemical or instrumental method.

3.3 Method of analysis shall be decided by mutual agreement between the manufacturer and the purchaser.

3.4 Product analysis, if desired by the purchaser, shall be carried out by the purchaser using test methods according to mutual agreement between the manufacturer and the purchaser. The chemical analysis shall conform to the permissible variations given in Table 2.

4. Tensile Properties — The tensile properties shall conform to the requirement specified in Table 3.

4.1 Tensile properties shall be determined by using any established standard method as agreed to between the manufacturer and the purchaser.

4.2 Tests on fracture toughness properties on welded structures are not mandatory, unless required by agreement between the manufacturer and the purchaser.

5. Manufacture — Manufacturing processes for the seamless fittings shall include casting, forging, forming and shaping operations, such as hammering, pressing, extruding, upsetting, rolling, bending or by use of combination of two or more such operations.

5.1 After the forming operations, the products will be subjected to non-destructive testing to ascertain that the products are free from any flaw, defect or crack after cleaning.

5.2 The welded fittings shall be manufactured by fusion welding processes and shall be carried out in an inert gas environment by welders qualified for carrying out welding by TIG and MIG process. Additionally, the welders should also have the knowledge of protective covering systems like trailing back up and side shields to avoid any contamination from the atmospheric pick up. Necessary care for proper surface preparation, joint design and joint fit up should be taken during the welding process to avoid any distortion and embrittling effect.

5.3 In case of welded fittings, two pieces from the same lot (meant for manufacture of the welded fitting) shall be taken separately and welding shall be carried out by using the same parameters as adopted for welding the concerned product.

TABLE 1 CHEMICAL COMPOSITION
(Clauses 2 and 3)

Element	Composition, Percentage						
	Grade A	Grade B	Grade C	Grade D	Grade E	Grade F	Grade G
Nitrogen, Max	0·03	0·03	0·05	0·05	0·03	0·03	0·05
Carbon, Max	0·10	0·10	0·10	0·10	0·10	0·10	0·10
Hydrogen* bars (Max)	0·012 5	0·012 5	0·012 5	0·012 5	0·012 5	0·012 5	0·012 5
Billets	0·010	0·010	0·010	0·010	0·010	0·010	0·010
Iron*, Max	0·20	0·30	0·30	0·50	0·20	0·30	0·40
Oxygen, Max	0·18	0·25	0·35	0·40	0·18	0·25	0·20
Aluminium	—	—	—	—	—	—	5·5-6·75
Vanadium	—	—	—	—	—	—	3·5-4·5
Palladium	—	—	—	—	0·12-0·25	0·12-0·25	—
Residual elements† (each), Max	0·1	0·1	0·1	0·1	0·1	0·1	0·1
Residual elements† (total), Max	0·4	0·4	0·4	0·4	0·4	0·4	0·4
Titanium‡	Remainder	Remainder	Remainder	Remainder	Remainder	Remainder	Remainder

*Lower values may be obtained by negotiation with the manufacturer.

†A residual is an element present in small quantities inherent to the manufacturing process but not added intentionally. This need not be reported.

‡The percentage of titanium is determined by difference.

TABLE 2 PERMISSIBLE VARIATIONS IN PRODUCT ANALYSIS
(Clauses 2 and 3.4)

Element	Product Analysis Limits, Max or Range, Percent	Permissible Variation in Product Analysis, Percent
Nitrogen	0·05	+0·005
Carbon	0·10	+0·92
Hydrogen	0·02	+0·002
Iron	0·50	+0·05
Oxygen	0·30	+0·03
Aluminium	4·0-6·75	±0·40
Oxygen	0·31-0·40, Max	±0·04
Vanadium	3·5-4·5	±0·15
Palladium	0·12-0·25	±0·02
Residual elements (each)	0·1	±0·02

TABLE 3 TENSILE PROPERTIES
(Clause 4)

Grade	Tensile Strength*, Min (MPa)	Yield Strength* (0·2 Percent Offset), Min (MPa)	Elongation in 40, Min, Percent	Reduction of Area, Min Percent
A	240	170	24	30
B	345	275	20	30
C	450	300	18	30
D	550	485	15	25
E	240	170	24	30
F	345	275	20	25
G	895	830	10	25

*These properties apply to longitudinal sections up to 75 mm in thickness with a maximum area of 65·0 cm². Mechanical properties of larger sections shall be negotiated between the manufacturer and the purchaser.

5.3.1 The weld quality shall be examined by observing the colour of weldments which gives the indication of the gases absorbed in the metal. Blue appearance of weldment indicates absorption of atmospheric gases which also gives as indication that the weldment is beyond its practical utility. Silvery grey appearance is considered suitable.

5.3.2 Weld procedure shall be as agreed to between the purchaser and the manufacturer.

6. Hydrostatic Tests — The tubular seamless or welded fittings shall have the capability of withstanding hydrostatic pressure without any failure, collapse, leakage or any other impairment unsuitable for service as described below.

6.1 The prescribed maximum hydrostatic pressure shall not exceed a value which will produce in the material a stress equal to 50 percent of yield strength of material. The pressure shall be determined by the following equation:

$$P = 2St/D$$

where

P = maximum hydrostatic pressure (MPa);

S = allowable fibre stress of one half the minimum yield strength, MPa;

t = thickness, mm; and

D = outside diameter of tube, mm.

6.2 Hydrostatic pressure shall not be maintained for less than 5 seconds.

7. Workmanship and Finish — All fittings shall conform to the dimensional tolerances on drawings furnished by the purchaser. The fittings shall be free from injurious external imperfections of a nature that will interfere with the purpose for which it is intended to be used. The basis of purchase shall be as given in Appendix A.

7.1 The fittings may be cleaned, pickled, descaled and brightened to achieve a finish as prescribed by the purchaser or as decided by mutual agreement between the purchaser and the manufacturer. The recommended procedure is given in Appendix B.

8. Marking

8.1 Each product shall be marked by stamping, stenciling or electroetching with the following particulars:

- a) Manufacturer's name or trade-mark;
- b) Grade of material;
- c) Finishing process;
- d) Dimensions; and
- e) Identification number, year and month of manufacture.

8.1.1 Standard Marking — Details available with the Bureau of Indian Standards.

8.2 If steel stamps are used, they shall be applied prior to heat treatment and care should be taken to see that marking is not deep enough to cause cracking or to reduce the wall thickness of the fitting below the minimum allowed.

8.3 When size of the product do not permit the complete marking, identification marks may be omitted in the sequence given in **8.1(e)**.

9. Stress-Relieving Heat Treatment — Stress-relieving operation, depending on application, to be mutually discussed and as agreed to between the contracting parties. Generally, stress-relieving can be carried out by holding the product at $600 \pm 10^\circ\text{C}$ in an inert atmosphere for not less than half-an-hour per 25 mm thickness.

9.1 Minimum time for stress relieving at 600°C is 15 minutes. All products which have been subjected to heat treatment shall be finished in accordance with Appendix B.

10. Inspection and Certification — Inspection and testing schedule, prior to shipment, shall be as agreed to between the purchaser and the manufacturer.

10.1 Surface inspection by liquid dye penetrant examination may be carried out on external surface to the acceptance standard which is to be mutually agreed upon between the manufacturer and the purchaser.

10.2 Non-Destructive Examination — Radiographic examination shall be made on the critical parts of finished product and components. The procedure and the acceptance criteria shall be mutually decided by the manufacturer and the purchaser.

11. Certificate — A certificate shall be furnished by the manufacturer stating that the finished fittings conform to this specification.

APPENDIX A

(Clause 7)

BASIS OF PURCHASE

A-1. Orders for material conforming to this specification shall include the following information:

- a) Grade and chemical requirement,
- b) Quantity and marking,
- c) Method of manufacture and finish,
- d) Heat-treatment,
- e) Non-destructive tests, and
- f) Inspection and packaging.

APPENDIX B

(Clauses 7.1 and 9.1)

RECOMMENDED PROCEDURE FOR ACHIEVING A GOOD FINISH

B-1. Mechanical Blast Cleaning Method — Mechanical blast cleaning methods, such as sand blasting, shot blasting or grit blasting may be used to remove hotwork scales and lubricants from titanium surfaces.

B-1.1 The sand for blast cleaning shall be of high grade, iron free silica sand.

B-1.2 If steel shots/grits and iron containing sand is used for blast cleaning, the blasted surface should be acid pickled to remove embedded steel particles on the surface.

B-1.3 The blast cleaning induces the compressive stresses in the material and warpage may occur in sections that are subsequently chemically treated.

B-1.4 Oxides and heat tints developed below 593°C may be removed by pickling in an acid solution of following composition:

Nitric acid : 10 to 20 volume percent
(150 to 300 g/litre)

Hydrofluoric acid : 1 to 2 volume percent
(24 to 42 g/litre)

Solution shall be prepared in distilled water and pickling shall be carried out at about 50°C. Pickling shall be carried out for a period which is just sufficient to remove the scales and tint. Pickling may be carried out following mechanical abrading. After pickling, the product shall be thoroughly rinsed in distilled water until acid is washed out of the surfaces. After pickling and distilled water rinse, the product may be immersed in a 10 to 40 volume percent solution of sulphuric acid (95 percent solution by weight) in distilled water to remove the converged scales. Recommended temperature for sulphuric acid wash is 66°C.

B-1.5 Brightening may be accomplished by following an acid treatment as given below.

B-1.5.1 A solution of nitric acid 10 to 30 volume percent (150 to 450 g/litre) and hydrofluoric acid 1 to 3 volume percent (12 to 36 g/litre) in distilled water (ratio of HNO₃ : HF, 10 : 1) is prepared. A pickled and rinsed product shall be immersed in this solution for a short time until a brightening finish is obtained.

Note — In the nitric-hydrofluoric acids pickling solution, the ratio of nitric acid to hydrofluoric acid is more important than the concentration of either of these two acids. When this ratio is maintained at 10 to 1, hydrogen absorption during pickling is minimized.

EXPLANATORY NOTE

Titanium and its alloys possess high specific strength and excellent corrosion resistance, and are being increasingly used in many chemical, aerospace and other industrial applications. These alloys are also being used in the form of seamless and welded fittings in chemical and marine industries because of their well known properties such as excellent corrosion resistance and high strength to weight ratio.

This standard is intended to stipulate the requirements of such fittings which are generally used for general corrosion resistance, marine and high temperature services.